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OF THE

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

WEST RALEIGH

COTTONSEED MEAL FEEDING EXPERIMENTS WITH MULES AND HORSES

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THE NORTH CAROLINA

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WEST RALEIGH, N. C.

TABLE OF CONTENTS.

	PAGE
Summary	151
Feeding Cottonseed Meal to Draft Animals	153
Objects of Experiment	154
Concentrated Feeds Used	154
Roughage Feeds Used	154
Cost and Combination of Feeds	155
Weights of Animals	155
Plan of the Experiment	155
Preparation of Rations	156
Ear Corn and Cottonseed Meal, Preliminary Test	156
Shelled Corn and Cottonseed Meal, Preliminary Test	156
Shelled Corn and Cottonseed Meal, Final Test	159
Ear Corn, Corn-and-Cob Meal and Cottonseed Meal	162
Corn-and-Cob Meal, Wheat Bran and Cottonseed Meal	166
External Effects of Cottonseed Meal on Draft Animals	168
General Observations and Conclusions	169

SUMMARY.

Cottonseed meal that is fresh and free from an excessive amount of hulls can be fed to work stock in quantities ranging from ten to fifteen per cent of the total ration by weight without any apparent harmful results. In certain cases, however, cottonseed meal may be refused by the animal. This condition may be permanent or it may be only temporary, the animal later acquiring an appetite for the meal.

If the ration exceeds two pounds daily to any extent, it will likely be refused after a period of three months or thereabouts. In exceptional cases more than two pounds can be fed with very satisfactory results.

It is not practical to feed cottonseed meal as a supplement to an ear corn ration. The most successful ration can be compounded from a basal feed which has previously been crushed or ground. Such feeds as bran, oats, brewers' grains or ground corn can be used for this purpose with good results.

Small quantities of cottonseed meal can, without doubt, be used in the ration for work stock with beneficial results to the animal and to the fertility of the soil through the manure. The experience of the writer shows, however, that while stock may not be severely injured, they go off feed suddenly when the meal is unduly increased, making it necessary to eliminate it temporarily until normal conditions can be restored.

Cottonseed meal should be fed always in combination with other feeds. While some mules may eat it greedily in the concentrated form, the nature of the meal makes it especially adapted for feeding with coarser and lighter feeds, such as wheat bran, oats, or crushed corn. The high protein content of cottonseed meal also precludes its use in the ration except as a supplementary feed.

Considering the market price of cottonseed meal, the addition of this concentrate will not cheapen the ration, at least to any material extent. The value of the meal must be derived largely from its beneficial effect in keeping the digestive system and the general health of the animal in better repair, and from the added value of the manure resulting from its use.

The most palatable and efficient rations used in the experiment were composed of corn-and-cob meal, wheat bran, and cottonseed meal, although these rations were more expensive for the total period and per hour of work than the other rations fed in comparison.

The rations composed of shelled corn six parts, and cottonseed meal one part, were less expensive for the total period than the corn rations in each case. They were also more economical per hour of work, with one exception where the animal did only two-thirds the amount of work performed by the other, which increased the cost per hour of work. This mixture, however, was not as palatable as other combinations used.

The rations composed of ear corn, corn-and-cob meal, and cottonseed meal were cheaper for the total period than the corn rations and with one exception they were slightly less expensive per hour of work than the corn rations. This combination, however, was not as palatable or satisfactory as the corn-and-cob meal, wheat bran, and cottonseed meal rations.

It is not practical to replace more than two pounds of corn in the ration with one pound of cottonseed meal. Under average conditions if the substitution is in the proportion of one pound of cottonseed meal to one and one-half pounds of corn, the results will generally be more satisfactory.

In three of the four experiments performed, each time with six mules, the cottonseed meal rations were somewhat cheaper for the total period in each case. In these same three experiments, with only two exceptions, the average cost per hour of work was also cheaper for the mules getting cottonseed meal.

Out of the thirteen cottonseed meal rations fed in three experiments, each ration containing cottonseed meal was cheaper for the total period than the corn rations fed in comparison. In two cases only was the cost per hour of work greater with the cottonseed meal rations.

In the fourth experiment, summarized in Table 10, the total cost of the cottonseed meal rations was greater in each case than the corn rations. Likewise, the cost per hour of work was greater with the mules fed the cottonseed meal rations. This marked difference in cost is attributed to the use of an all corn-and-cob meal ration supplemented with wheat bran and cottonseed meal.

Intermittent feeding is practiced by some farmers. If the meal is used in this way, it is fed for a period of three or four months and then discontinued for a considerable length of time. This will depend on the appetite of the animal and the amount of meal fed.

It has been claimed that work stock fed on cottonseed meal experience trouble from short wind and weakness of the eyes. In three years' experimental work no trouble whatever has arisen which could be attributed to the cottonseed meal.

Cottonseed meal may be used in the ration for work stock when practical to do so, but it should be fed moderately and with judgment. It is the most concentrated commercial feed on the market, and to obtain its maximum value it should be used first as a feed and then as a fertilizer.

If cottonseed meal was fed to the work stock of this State alone, they would use individually 500 pounds per year, or a total of 90,000 tons. If so used, it would reduce the amount of corn fed in an equal degree at least and add materially to the fertility of the soil from the manure produced.

COTTONSEED MEAL FEEDING EXPERIMENTS WITH MULES AND HORSES

By R. S. Curtis.

Feeding Cottonseed Meal to Draft Animals.

The value of cottonseed meal as a feed for work stock has never been clearly established by definite feeding experiments. It has been recommended for this purpose for a number of years, but some writers advocating its use have done so from theoretical considerations, rather than from practical or experimental results. In some cases larger quantities of the meal have been recommended in the proposed ration than experimental results show can be used practically.

The claim has been made also that equally as detrimental results follow the feeding of cottonseed meal to work stock as to hogs, sheep, calves, and mature cattle. This statement has been corroborated by letters from practical farmers stating that when the meal is fed in excess it causes short wind and weakness of the eyes. While these statements are not questioned, under the conditions involved, yet if the meal is fed with judgment, no trouble should arise.

The prejudice against feeding cottonseed meal to work stock has been very strong, and for this reason its use has been limited to a very small number of farmers. Doubtless a great many have tried to feed the meal to work stock and upon finding the immediate results unsatisfactory have discontinued it in the ration. Louisiana planters who keep a large number of horses and mules on their sugar plantations have, without doubt, been the most ardent advocates of its use. According to the results given by them, cottonseed meal has not only proved to be a practical substitute in part for corn and other concentrates, but under their conditions it has cheapened the rations in certain instances and improved the working capacity of the animals.

It may seem to some readers of this publication that the writer is attempting to decry the use of cottonseed meal as a feed for work stock. This is not the case, however, as the importance of this commercial concentrate in the South and the desirability of introducing its protein content into the ration for work animals is keenly felt. The calls for information regarding the feeding of cottonseed meal to work animals have become quite numerous. It is the intention to answer through this publication, either directly or indirectly, many of the questions which have been submitted and could not be answered previously, owing to the dearth of experimental data on the subject.

Whenever conditions make it possible, it is considered judicious to use cottonseed meal as a partial substitute for corn or other feeds which may be in use. The purpose of this publication, however, is not to advise the indiscriminate use of cottonseed meal for work animals, but rather to show some of the important factors to consider in using it. There is doubtless a wide variation in the success obtained in feeding the meal. This may come from various causes which are not well un-

derstood by the average feeder. It is for those who have not been successful, and others who wish to know how to use this feed for horses and mules, that this experimental data is given.

Objects of Experiment.

The three chief objects of these experiments were to determine—

1. The possibility of using cottonseed meal successfully in rations for work animals.
2. The form in which cottonseed meal may be used most successfully and the feeds with which it may be combined most satisfactorily.
3. The harmful results, if any, to the animals, from the standpoint of health, condition and working capacity.

Concentrated Feeds Used.

During the experiment, corn, cottonseed meal and wheat bran were used. The corn was fed on the ear, shelled, and in the form of corn-and-cob meal during the successive stages of the experiment. The corn used was all produced on the Experiment Station farm, while the wheat bran and cottonseed meal were purchased at prevailing market prices.

The composition of the feeds used was on the average as follows:

TABLE 1—GIVING PERCENTAGE COMPOSITION OF CONCENTRATED FEEDS.

Feeds.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen Free Extract.	Fat.
Corn (shelled)[1]	10.6	1.5	10.3	2.2	70.4	5.0
Corn-and-cob meal[2]	15.1	1.5	8.5	6.6	64.8	3.5
Cottonseed meal[3]	8.0	6.5	41.0	6.5	29.0	9.0
Wheat bran[4]	11.9	5.8	15.4	9.0	53.9	4.0

It can be seen from Table 1 why it is desirable to combine a small quantity of cottonseed meal with the corn ration for work animals. Corn is very low in protein and exceptionally high in carbohydrates, while cottonseed meal is low in carbohydrates and high in protein. Protein being the nutrient especially low in corn, it can be seen why it is desirable to combine the two feeds. While the other nutrients of these feeds are important, the protein and carbohydrates are of special significance in this case.

Roughage Feeds Used.

The same kind of roughage was fed to each of the mules during corresponding periods in the experiment. Corn stover was the principal roughage fed. At various times the roughage consisted of oat hay, pea vine hay, and mixed hays, although the amount of these fed was a comparatively small part of the total roughage used. The amount of roughage supplied was determined by the appetite, the condition of

[1] Feeds and Feeding, Henry, Page 565—Tenth Edition.
[2] Feeds and Feeding, Henry, Page 565—Tenth Edition.
[3] North Carolina Experiment Station Chart—C. B. Williams.
[4] Feeds and Feeding, Henry, Page 565—Tenth Edition.

the animals and the amount of work they were doing. The quantity of roughage given ranged from twelve to eighteen pounds per animal daily. The coarser portions of the corn stover were naturally refused, so that the actual amount eaten ranged from twelve to fifteen pounds per animal daily. A larger proportionate quantity of the other roughage feeds used was actually eaten.

Cost and Combination of Feeds.

The value of the feeds used in the experiment was placed as follows: Ear corn, $20 per ton; shelled corn, $25 per ton; corn-and-cob meal, $20 per ton; cottonseed meal, $30 per ton, and wheat bran, $30 per ton. On a pound basis, the following values were deduced for the single feeds and the combinations of feeds used:

TABLE 2—SHOWING THE COST PER POUND IN CENTS OF THE FEEDS AND RATIONS USED.

Feeds.	Cost in Cents Per Pound.
Ear corn	1.00
Corn (shelled)	1.25
Corn-and-cob meal	1.00
Cottonseed meal	1.50
Wheat bran	1.50
Corn-and-cob meal, 8 parts; wheat bran, 2 parts	1.10
Corn-and-cob meal, 7 parts; wheat bran, 2 parts; cottonseed meal, 1 part	1.15
Corn-and-cob meal, 6 parts; wheat bran, 2 parts; cottonseed meal, 2 parts	1.20

The cost of any of the rations can readily be determined by these figures. In making up the tables involving the cost of the rations, these figures were used.

Weights of Animals.

During the first series of the experiment, which extended from October, 1908, to March, 1909, the mules were weighed every two weeks. During the remaining series, weighings were made each week. The averages for each month given in the tables are taken from these figures. It is important that these averages be used instead of the individual weights, which fluctuate from day to day.

Plan of the Experiment.

In every case, excepting the preliminary experiment with shelled corn and cottonseed meal reported in Table 3, the mules were worked in teams, whenever possible, one mule getting the cottonseed meal ration, and the other the corn products ration. As a limited amount of the farm work is performed with implements requiring only one animal, the amount of work varied in some cases. This condition, to a certain extent, influenced the quantity of feed eaten and the weights obtained, although in most cases the work performed was fairly well balanced with each team.

PREPARATION OF RATIONS.

Ear Corn and Cottonseed Meal—Preliminary Test.

As corn forms the principal concentrated ration for work animals in the majority of cases on Southern farms, the cottonseed meal was first combined with ear corn. Although this was not considered a desirable ration, it was thought best to determine whether the meal would be relished in this form, since the preparation needed would involve the least amount of work for the farmer. The meal was first fed to each animal at the rate of three-fourths of a pound per day divided into three equal feeds. For a time, it was apparently relished by the animals, although the ear corn was generally eaten first. In rare cases the cottonseed meal was first consumed, but when this was true the appetite of the animal could not be considered normal. Later observations corroborated this conclusion, as well as data received from farmers who were feeding cottonseed meal to a large number of animals. In reply to the question whether work animals had ever absolutely refused cottonseed meal, the answer was invariably in the negative when the meal was properly mixed with other feeds. When fed alone, however, or when not properly mixed with the other concentrates, the reply was generally stated in the affirmative. This is conclusive in the mind of the writer, and emphasizes the importance of using cottonseed meal only as a supplement in the ration, thoroughly mixed with the basal feeds.

The cottonseed meal was fed as a supplementary feed to ear corn for a period of four months. During this time it was eaten with a fair degree of satisfaction. At times considerable quantities of the meal were left uneaten. While the amount of cottonseed meal was gradually increased to one and one-half pounds per day and sometimes slightly more, only occasionally was this quantity eaten with satisfaction. In rare instances, animals will be found which will consume this amount of cottonseed meal fed with ear corn, but this is the exception rather than the rule. It would not be well, however, to feed a concentrate like cottonseed meal in this manner, even though it were consumed readily. It has been found that it was not only necessary, but advisable for other reasons, to mix the meal with crushed or ground feeds to secure uniformly satisfactory results.

Shelled Corn and Cottonseed Meal—Preliminary Test.

The next step taken in the experiment was to combine cottonseed meal with shelled corn. The monthly records obtained from this work are reported in Table 3. While this experiment was performed during the season of the year in which the farm work is usually lightest, it will be seen from the table that each mule averaged between four and five hours' work per day.

TABLE 3—SHOWING RESULTS OBTAINED FROM FEEDING SHELLED CORN VERSUS SHELLED CORN AND COTTONSEED MEAL. FEED CONSUMED AND WORK PERFORMED DURING EACH MONTH, 1908-1909.

Number Mule.	1.						2.					
Ration.	Shelled Corn.						Shelled Corn and Cottonseed Meal.					
Month.	Pounds Feed Consumed.		Cost of Feed per Month.	Average Weight for Month.	Hours Work Performed.	Cost of Feed Per Hour of Work in Cents.	Pounds Feed Consumed.		Cost of Feed per Month.	Average Weight for Month.	Hours Work Performed.	Cost of Feed Per Hour of Work in Cents.
	Shelled Corn.	Cottonseed Meal.					Shelled Corn.	Cottonseed Meal.				
October	372.0	------	$4.65	1150.0	197.0	2.36	204.6	69.7	$3.60	1050.0	191.0	1.88
November	400.5	------	5.00	1122.5	223.0	2.24	262.8	67.5	4.30	1022.5	230.0	1.87
December	408.3	------	5.10	1201.3	140.5	3.63	307.5	55.5	4.68	1095.0	185.0	2.53
January	354.3	------	4.42	1242.0	29.5	15.00	270.3	38.6	3.95	1140.0	58.5	6.77
February	266.6	------	3.32	1245.0	42.0	7.92	207.3	29.6	3.03	1151.0	38.0	8.00
March	320.6	------	4.00	1172.0	184.0	2.12	244.1	34.8	3.57	1073.0	199.0	1.79
Total	2122.5	------	26.49	1188.8	816.0	3.25	1496.7	295.7	23.13	1088.6	901.5	2.57
Number Mule.	3.						4.					
Ration.	Shelled Corn and Cottonseed Meal.						Shelled Corn and Cottonseed Meal.					
October	316.2	23.2	$4.30	1115.0	180.5	2.38	260.4	46.5	$3.95	1065.0	174.0	2.27
November	354.6	22.5	4.77	1077.5	229.0	2.08	308.7	45.0	4.53	1015.0	213.0	2.13
December	339.0	21.2	4.56	1138.3	146.5	3.11	315.0	45.0	4.61	1088.0	112.5	4.10
January	252.0	15.7	3.38	1129.0	60.5	5.59	267.7	38.2	3.91	1146.0	54.0	7.26
February	204.0	12.7	2.74	1154.0	39.0	7.00	220.5	31.5	3.22	1159.0	39.0	8.28
March	261.0	16.3	3.48	1101.0	201.0	1.74	241.5	34.5	3.53	1089.0	168.5	2.09
Total	1726.8	111.6	23.23	1119.1	856.5	2.71	1613.8	240.7	23.75	1093.6	761.0	3.12
Number Mule.	5.						6.					
Ration.	Shelled Corn and Cottonseed Meal.						Shelled Corn and Cottonseed Meal.					
October	334.8	23.2	$4.53	980.0	214.5	2.11	297.6	46.5	$4.41	882.5	198.0	2.23
November	376.6	22.5	5.04	1010.0	230.5	2.19	352.8	45.0	5.08	897.5	210.0	2.42
December	392.0	23.0	5.24	1057.0	178.0	2.94	375.2	36.5	5.23	977.0	166.0	3.15
January	328.3	19.3	4.39	1093.0	47.5	9.25	328.1	26.2	4.49	1016.0	62.0	7.25
February	251.8	14.8	3.37	1113.0	41.0	8.22	259.3	20.7	3.55	1025.0	70.5	5.04
March	251.8	14.8	3.37	1016.0	121.0	2.78	259.3	20.7	3.55	954.0	129.0	1.97
Total	1935.3	117.6	25.94	1044.9	832.5	3.12	1872.3	195.6	26.31	958.7	835.5	3.15

In presenting Table 3, giving the details of the first experiment, some points of special significance are brought out. It will not be out of place to say that this work has not been entirely satisfactory, owing to the variations arising by the refusal of some mules to eat the cottonseed meal rations readily. It was this difficulty which prevented definite conclusions on every phase of the problem. By following the table of monthly results, a large number of details can be brought out which otherwise would be impossible in a publication of this nature.

In the beginning of the experiment, the rations were figured on a theoretical basis so as to substitute one, two and three parts of cottonseed meal, by weight, for one part of corn. It was soon learned, however, that some of these substitutions could not be carried out in practice. This was true of the rations containing the larger quantities of cottonseed meal. For this reason the figures may not show in every case the proportion used in the beginning, as it was necessary to make variations to suit the taste of each individual animal.

Under the column headed "Feed Consumed" it will be noticed in certain instances that it was necessary to reduce the amount of cottonseed meal originally incorporated in the ration. In this particular experiment, it was undertaken to substitute one part of cottonseed meal for one part of corn in the ration for mules 3 and 5, two parts of cottonseed meal for one part of corn for mules 4 and 6, and three parts of cottonseed meal for one part of corn for mule 2, mule 1 being used as a check in each case. It was soon learned that it was impossible to substitute three parts of cottonseed meal for one part of corn in the ration. In every case where this was tried, the mules not only practically refused the ration, but grew very thin in condition and were unable to do the regular work required of them until the ration was changed. Two parts of cottonseed meal can be substituted for one part of corn, but it has been found that one and one-half parts of cottonseed meal to one part of corn, or in the proportion of three to two, gives more satisfactory results in a general way. From this work the conclusion has been reached that the substitution should not exceed two parts of cottonseed meal for one part of corn and the total amount of cottonseed meal fed should rarely if ever exceed two pounds per day. Under average conditions one and one-half pounds of cottonseed meal will come nearer being a normal feed, considering the size of our work stock and the amount of work done.

TABLE 4—GIVING SUMMARY OF RESULTS CONTAINED IN TABLE 3. FEEDING PERIOD OCTOBER TO MARCH, 1908-1909.

Number of Mule.	Pounds Feed Consumed.		Cost of Feed for Period.	Hours Work Performed During Period.	Average Cost of Feed Per Hour of Work in Cents.	Initial Weight—October.	Final Weight—March.	Gain or Loss in Weight.
	Shelled Corn.	Cottonseed Meal.						
1	2122.5		$ 26.49	816.0	3.25	1150.0	1172.0	22.0
2	1496.7	295.7	23.13	901.5	2.17	1050.0	1073.0	23.0
3	1726.8	111.6	23.23	856.5	2.71	1115.0	1101.0	—14.0
4	1613.8	240.7	23.75	761.0	3.12	1065.0	1089.0	24.0
5	1935.3	117.6	25.94	832.5	3.12	980.0	1016.0	36.0
6	1872.3	195.6	26.31	835.5	3.15	882.5	954.5	71.5

The above summary is taken from Table 3, giving the results obtained from the first experiment performed with cottonseed meal. This work was more in the nature of a preliminary experiment to determine the amount of cottonseed meal which could be fed per day under the conditions given. In order to get as many data as possible regarding this point, only one mule was fed corn. The others were fed cottonseed meal in varying amounts as shown previously in Table 3, which gives the important details of the work.

In every case as shown by the above summary, the mules fed the cottonseed meal rations were maintained for the period at a slightly less cost than the mule fed the corn ration. The rations for mules 1, 5 and 6 cost approximately the same. Likewise, the ration for mules 2, 3 and 4 cost practically the same. The cost per hour of work was less for the mules fed cottonseed meal, although the difference was not great. In one instance only was there a loss in weight which was for mule 3 fed a cottonseed meal ration. With this one exception, the mules fed the cottonseed meal rations gained more than the mule fed the corn ration.

Shelled Corn and Cottonseed Meal—Final Test.

The experiment reported in Table 5 is really a repetition of the first experiment performed and summarized in Table 4. However, in the second experiment one mule in each team was fed the shelled corn ration, while each team mate was given the cottonseed meal ration. In the first test the work was more in the nature of a preliminary experiment, five of the mules being fed cottonseed meal. In the case under consideration, however, the test was equalized as nearly as possible in each team from the standpoint of feed consumed and work performed. With mule 6 the work was exceptionally light and the cost per hour of work was much higher than the average for the other animals.

The total cost for the period was somewhat lower in this case, and especially was this difference true with the team mate of mule 6.

It is not considered that this combination of shelled corn and cottonseed meal is really practical from every standpoint. The principal drawback is that the ration is not as palatable as it should be, consequently not readily eaten. From the standpoint of economy it was one of the most successful rations tried. If it is necessary for any reason that the farmer feed cottonseed meal in connection with shelled corn, it is advisable to do so rather than to eliminate the meal from the ration entirely. The best results, from the standpoint of palatability and efficiency, will not be obtained from this ration, however. It should always be remembered that the meal is a heavy concentrate and should be uniformly mixed with some light feed like wheat bran for best results. The writer has found this true in his experimental work, and farmers who are successfully feeding the meal have reached the same conclusion. While the meal can be fed as a supplement to shelled corn, the most satisfactory results will not be obtained in this way.

TABLE 5—SHOWING THE RESULTS OBTAINED FROM FEEDING SHELLED CORN VERSUS SHELLED CORN AND COTTONSEED MEAL. FEED CONSUMED AND WORK PERFORMED DURING EACH MONTH, 1909–1910.

Number Mule.	1.					2.					
Ration.	Shelled Corn.					Shelled Corn 6 Parts, Cottonseed Meal 1 Part.					
Month.	Pounds Feed Consumed.	Cost of Feed per Month.	Average Weight for Month.	Hours Work Performed.	Cost of Feed per Hour of Work in Cents.	Pounds Feed Consumed. Shelled Corn.	Pounds Feed Consumed. Cottonseed Meal.	Cost of Feed Per Month.	Average Weight for Month.	Hours Work Performed.	Cost of Feed per Hour of Work in Cents.
September	224.0	$2.80	1170.0	149.0	1.88	164	30.0	$2.50	1162.5	148.0	1.69
October	242.0	3.02	1167.0	169.5	1.78	183	30.5	2.74	1144.0	204.5	1.34
November	258.0	3.22	1193.2	188.0	1.71	199	29.5	2.93	1158.4	190.0	1.54
December	270.0	3.37	1189.5	98.0	3.44	228	28.5	3.28	1148.0	96.0	3.42
January	270.0	3.37	1188.5	112.0	3.01	210	26.2	3.02	1149.0	82.0	3.68
February	247.5	3.09	1153.3	110.0	2.81	186	23.3	2.67	1142.0	66.0	4.05
Total	1511.5	18.87	1176.9	826.5	2.28	1170	168.0	17.14	1150.6	786.5	2.18

Number Mule.	3.					4.					
Ration.	Shelled Corn.					Shelled Corn 6 Parts, Cottonseed Meal 1 Part.					
September	224	$2.80	1160.0	170	1.65	164.0	28.2	$2.48	1219.5	171	1.45
October	244	3.05	1136.0	190	1.61	184.5	29.7	2.75	1212.5	213	1.29
November	258	3.22	1178.0	185	1.74	199.0	29.5	2.93	1244.4	181	1.62
December	280	50	1189.0	76	4.61	222.0	27.7	3.19	1235.0	56	5.70
January	265	3.31	1193.0	89	3.72	212.0	26.5	3.05	1236.5	85	3.59
February	245	3.06	1163.3	124	2.47	202.0	25.2	2.90	1230.6	132	1.44
Total	1516	18.94	1169.9	834	2.27	1183.5	166.8	17.30	1229.7	838	2.06

Number Mule.	5.					6.					
Ration.	Shelled Corn.					Shelled Corn 6 Parts, Cottonseed Meal 1 Part.					
September	224	$2.80	1105.5	155	1.81	164.0	30.0	$2.50	1053.5	42.0	6.00
October	246	3.07	1091.0	193	1.59	190.5	27.7	2.80	1053.5	106.5	2.63
November	258	3.22	1096.8	65	4.95	198.0	30.0	2.92	1070.8	53.0	5.51
December	285	3.56	1079.5	81	4.40	226.0	28.2	3.25	1072.5	28.0	1.60
January	270	3.37	1067.0	50	6.74	202.0	25.2	2.90	1063.0	51.0	5.70
February	245	3.06	1047.3	94	3.26	192.0	24.0	2.76	1054.0	64.0	4.31
Total	1528	19.08	1081.2	638	2.99	1172.5	165.1	17.13	1061.2	344.5	4.97

TABLE 6—GIVING SUMMARY OF TABLE 5. FEEDING PERIOD—SEPTEMBER TO FEBRUARY, 1909–1910.

Number of Mule.	Pounds Feed Consumed.		Cost of Feed for Period.	Hours Work Performed.	Average Cost of Feed per Hour of Work in Cents.	Initial Weight—September.	Final Weight—February.	Gain or Loss in Weight.
	Shelled Corn.	Cottonseed Meal.						
1	1511.5		$18.87	826.5	2.28	1170.0	1153.3	—16.7
2	1170.0	168.0	17.14	786.5	2.18	1162.5	1142.0	—20.5
3	1516.0		18.94	834.0	2.27	1160.0	1163.3	3.3
4	1183.5	166.8	17.30	838.0	2.06	1219.5	1230.6	11.1
5	1528.0		19.08	638.0	2.99	1105.5	1047.3	—58.2
6	1172.5	165.1	17.13	344.5	4.97	1053.5	1054.0	.5

It is shown in the above table that the cottonseed meal rations fed were cheaper in every case than the corn rations. Whether this will prove to be true under like conditions for each animal, the writer is unable to say, as the conditions in this case were not the same for each animal. The work performed by the mules getting cottonseed meal was with one exception less than the amount of work performed by the mules fed corn. The cost per hour of work was also less, for the mules fed cottonseed meal, with the exception of mule 6, for which the cost was high, owing to the small amount of work performed. In two cases out of three in which gains were made, they were in favor of the mules getting cottonseed meal in their ration. In the other three instances slight losses in weight were recorded. In these cases each of the two mules fed cottonseed meal lost somewhat more than the mule fed corn alone.

Ear Corn, Corn-and-Cob Meal, and Cottonseed Meal.

During the time of the preliminary test with ear corn and cottonseed meal, a combination of ear corn, corn-and-cob meal and cottonseed meal was fed to three of the farm mules. The same amount of cottonseed meal was mixed with the corn-and-cob meal that was used in connection with the ear corn. It was evident after a few weeks' observation that the cottonseed meal was eaten much more satisfactorily in connection with corn-and-cob meal than with ear corn. That the meal was relished more was evident from the fact that a larger quantity of it was consumed and the mules remained in better condition. In one case over two pounds were eaten per day, which was more than had ever been eaten satisfactorily when fed as a supplement to ear corn. This ration was not entirely satisfactory, although the final results, from the standpoint of work performed and the condition of the mules, showed great improvement. A small amount of wheat bran, three to

four pounds per day, was used later in the ration of corn-and-cob meal and cottonseed meal. This materially increased the palatability of the ration. In fact, the last series of the experiment was carried on with this mixture of feeds. The cottonseed meal seemed to mix better with wheat bran than with the corn-and-cob meal alone. This is important, because horses and mules do not like the presence of the pure meal. If this can be concealed by the addition of some feed, much more satisfactory results will be obtained. This statement is corroborated by the results which the Louisiana planters get by using black strap molasses in their rations. When this is done, they rarely if ever report a case of the meal being refused by work stock.

The final results obtained from feeding cottonseed meal in combination with corn-and-cob meal, both feeds in conjunction with ear corn, are shown in Table 7. From a practical standpoint, the results obtained from this combination of feeds was a very decided improvement over the first test with ear corn as the basal feed. When fed with ear corn it was necessary that the cottonseed meal be eaten in the concentrated form, which is not advisable for several reasons, principally because of its concentration and likelihood of producing digestive troubles. When the meal was fed with corn-and-cob meal, the ration was not only lightened, but it was much more palatable and safer from every standpoint.

This ration of ear corn, corn-and-cob meal, and cottonseed meal is considered the most practical ration from the farmer's standpoint, because of the fact that home-grown feeds can be used entirely and the necessary preparation can be made on the farm. For the city teamster other feeds may possibly be purchased as cheaply as corn and may prove equally or more satisfactory than corn-and-cob meal for combining with cottonseed meal.

TABLE 7—SHOWING THE RESULTS OBTAINED FROM FEEDING EAR CORN VERSUS EAR CORN, CORN-AND-COB MEAL AND COTTONSEED MEAL. FEED CONSUMED AND WORK PERFORMED DURING EACH MONTH, 1909.

Number Mule.	1.					2.						
Ration.	Ear Corn.					Ear Corn 7 Parts, Corn-and-Cob Meal 3 Parts, Cottonseed Meal 1 Part.						
Month.	Pounds Feed Consumed.	Cost of Feed per Month.	Average Weight for Month.	Hours Work Performed.	Cost of Feed per Hour of Work in Cents.	Pounds Feed Consumed. Ear Corn.	Corn and Cob Meal.	Cottonseed Meal.	Cost of Feed per Month.	Average Weight for Month.	Hours Work Performed.	Cost of Feed per Hour of Work in Cents.
April	220.0	$2.20	1052.0	111.0	1.98	115.0	63.0	21.0	$2.09	1024.0	109	1.92
May	400.0	4.00	1069.3	151.5	2.64	230.0	108.0	36.0	3.92	1068.6	140	2.80
June	376.1	3.76	1098.4	233.5	1.61	225.0	90.0	30.0	3.60	1106.8	87	4.14
July	387.5	3.87	1121.0	223.0	1.74	232.5	93.0	31.0	3.72	1113.5	185	2.00
August	178.1	1.78	1114.6	64.0	2.78	112.5	42.7	14.2	1.76	1137.0	34	5.20
Total	1561.7	15.61	1091.1	783.0	2.00	915.0	396.7	132.2	15.09	1089.9	555	2.72

Number Mule.	3.					4.						
Ration.	Ear Corn.					Ear Corn 7 Parts, Corn-and-Cob Meal 3 Parts, Cottonseed Meal 1 Part.						
April	212.5	$2.12	1056.0	96.0	2.21	112.5	60.0	20.0	$2.02	1155.0	107.0	1.89
May	465.0	4.65	1078.6	164.5	2.83	232.5	139.5	46.5	4.41	1184.0	151.5	2.91
June	378.6	3.78	1098.4	240.0	1.59	228.0	89.2	29.7	3.61	1209.2	239.0	1.50
July	387.5	3.87	1117.5	220.0	1.75	232.5	93.0	31.0	3.72	1228.5	223.0	1.67
August	178.1	1.78	1152.0	37.5	4.74	112.5	42.7	14.2	1.76	1247.0	64.0	2.76
Total	1621.7	16.21	1100.5	758.5	2.14	918.0	424.4	141.4	15.52	1204.7	784.5	1.98

Number Mule.	5.					6.						
Ration.	Ear Corn.					Ear Corn 7 Parts, Corn-and-Cob Meal 3 Parts, Cottonseed Meal 1 Part.						
April	187.5	$1.87	1035.0	117.5	1.59	112.5	45.0	15.0	$1.80	994.0	52.0	3.46
May	387.5	3.87	1075.3	132.0	2.93	232.5	93.0	31.0	3.72	1023.3	135.0	2.76
June	375.0	3.75	1077.6	221.5	1.69	225.0	90.0	30.0	3.60	1010.0	231.5	1.55
July	387.5	3.87	1083.5	229.0	1.69	232.5	93.0	31.0	3.72	1013.5	232.0	1.60
August	178.1	1.78	1081.0	41.0	4.34	112.5	42.7	14.2	1.76	1005.0	67.0	2.64
Total	1515.6	15.15	1070.5	741.0	2.04	915.0	363.7	121.2	14.60	1009.2	717.5	2.03

Table 7 brings out the same point that was mentioned in a former discussion regarding the amount of cottonseed meal which can be fed with satisfaction. While the mules were not forced in this case, it was evident from observation that they were eating as much as they would take readily. The statement has already been made that when the meal was unduly increased, the mules were likely to go off feed suddenly. For this reason special precaution was taken to avoid this condition. The average amount which can be fed per day in the combination of feeds used in this test will be about one pound or ten per cent of the total ration by weight for a mule doing medium work. By feeding three parts of corn-and-cob meal to one part of cottonseed meal, a very thorough mixture of the cottonseed meal can be made. Disregarding cost, it is probable that an all corn-and-cob meal ration supplemented by cottonseed meal would have been better. The expense of preparation is too great, however, to follow this practice.

In this experiment, the average amount of cottonseed meal fed was about one pound per day. The experiment started the middle of April and ended the middle of August, consequently the small amount of cottonseed meal fed during these two months. With mules doing severe work, however, and by the use of a different basal ration, it is possible that more meal could have been given with satisfaction. It is considered that fifteen per cent of cottonseed meal on a basis of the total weight of the ration is the maximum amount which can be fed with satisfactory results.

TABLE 8—GIVING SUMMARY OF TABLE 7. FEEDING PERIOD APRIL TO AUGUST, 1909

Number Mule.	Pounds Feed Consumed.			Cost of Feed for Period.	Hours Work Performed.	Cost of Feed per Hour of Work in Cents.	Initial Weight—April.	Final Weight—August.	Gain or Loss in Weight.
	Ear Corn.	Corn-and-Cob Meal.	Cottonseed Meal.						
1	1561.7	----------	----------	$15.61	783.0	2.00	1052	1114.6	62.6
2	915.0	396.7	132.2	15.09	555.0	2.72	1024	1137.0	113.0
3	1621.7	----------	----------	16.21	758.5	2.14	1056	1152.0	96.0
4	918.0	424.4	141.4	15.52	784.5	1.98	1155	1247.0	92.0
5	1515.6	----------	----------	15.15	741.0	2.04	1035	1081.0	46.0
6	915.0	363.7	121.2	14.60	717.5	2.03	994	1005.0	11.0

The above combination of ear corn, corn-and-cob meal, and cottonseed meal was, with one exception, the most satisfactory ration used, from the standpoint of palatability. This one exception was the mixture of corn-and-cob meal, wheat bran and cottonseed meal. This combination was the most palatable of any mixture used, although it will usually be an expensive ration owing to the high cost of the wheat bran, and the large amount of corn-and-cob meal necessary.

It will be noticed in the summary given in Table 8 that the rations containing the cottonseed meal were in each case cheaper for the entire period than the ear corn ration; also, with one exception, the cost per hour of work was less in case of the mules fed cottonseed meal. Mule 4 did slightly more work during the experiment than any other animal, which accounts for the lower cost per hour of work. In every case there was an increase in the weight of the animals, and this experiment was performed during the hardest season of work, from April to August. With the exception of mule 2, however, the increase in weight was greater with the mules fed corn rations.

Corn-and-Cob Meal, Wheat Bran and Cottonseed Meal.

The last series of the experiment performed is reported in detail in Table 9. The higher cost of the cottonseed meal rations as compared with former rations is at once apparent. The addition of bran, and the larger quantity of corn-and-cob meal consumed is largely responsible for this result. Without doubt, this was the most palatable and satisfactory ration fed, barring cost. City teamsters, who of necessity must purchase all of their feeds, will find this ration a very satisfactory one, especially if they desire to use cottonseed meal. The peculiar flaky nature of wheat bran makes it a very desirable feed to mix with cottonseed meal. In addition to this fact, bran is an excellent laxative for work stock, as it has a mild purgative effect.

TABLE 9—SHOWING THE RESULTS OBTAINED FROM FEEDING CORN-AND-COB MEAL, WHEAT BRAN AND COTTONSEED MEAL. FEED CONSUMED AND WORK PERFORMED DURING EACH MONTH, 1910.

Number of Mule.	1.					2.				
Ration.	Corn-and-Cob Meal.					Corn and Cob Meal 8 Parts, Wheat Bran 2 Parts.				
Month.	Pounds Feed Consumed.	Cost of Feed per month.	Average Weight for Month.	Hours Work Performed.	Cost of Feed per Hour of Work in Cents.	Pounds Feed Consumed.	Cost of Feed per month.	Average Weight for Month.	Hours Work Performed.	Cost of Feed per Hour of Work in Cents.
July	280.5	$2.80	1082.5	212.5	1.32	314.5	$3.45	1054.7	211.5	1.64
August	327.5	3.27	1120.2	129.0	2.54	382.0	4.20	1076.4	158.0	1.66
September	330.0	3.30	1155.2	150.0	2.20	390.0	4.29	1097.2	155.0	2.77
October	341.0	3.41	1169.2	240.0	1.42	403.0	4.43	1129.5	240.0	1.80
November	330.0	3.30	1142.6	260.0	1.27	390.0	4.29	1125.6	260.0	1.65
December	341.0	3.41	1088.0	110.0	3.10	403.0	4.43	1121.7	110.0	4.03
Total	1950.0	19.49	1126.3	1101.5	1.77	2282.5	25.19	1100.8	1134.5	2.21

Number of Mule.	3.					4.				
Ration.	Corn-and-Cob Meal.					Corn-and-Cob Meal 7 Parts, Wheat Bran 2 Parts, Cottonseed Meal 1 Part.				
July	311.5	$3.11	1061.2	196	1.59	312.5	$3.59	1150.0	197	1.82
August	375.0	3.75	1116.4	147	2.55	378.5	4.35	1201.8	126	3.45
September	390.0	3.90	1128.0	98	3.98	390.0	4.48	1180.5	133	3.37
October	403.0	4.03	1162.7	195	2.07	403.0	4.63	1237.7	175	2.65
November	390.0	3.90	1179.6	230	1.70	390.0	4.48	1240.6	120	3.74
December	403.0	4.03	1205.0	------	------	403.0	4.63	1248.0	------	------
Total	2272.5	22.72	1142.1	866	2.62	2277.0	26.16	1209.8	751	3.48

Number of Mule.	5.					6.				
Ration.	Corn-and-Cob Meal.					Corn-and-Cob Meal 6 Parts, Wheat Bran 2 Parts, Cottonseed Meal 2 Parts.				
July	274.5	$2.74	1089.0	212.5	1.29	110.0	$1.32	1006.2	177.5	.74
August	335.5	3.35	1142.0	142.0	2.36	275.0	3.30	1082.0	68.0	4.85
September	345.0	3.45	1139.5	145.0	2.38	303.5	3.64	1114.0	110.0	3.31
October	356.5	3.56	1185.0	160.0	2.23	325.5	3.90	1074.2	120.0	3.25
November	345.0	3.45	1196.6	210.0	1.64	330.0	3.96	1088.2	90.0	4.40
December	356.5	3.56	1185.5	40.0	8.91	418.5	5.02	1093.0	------	------
Total	2013.0	20.11	1156.2	909.5	2.21	1762.5	21.14	1076.3	565.5	3.74

TABLE 10—GIVING SUMMARY OF TABLE 9. FEEDING PERIOD, JULY TO DECEMBER, 1910.

Number of Mule.	Pounds Feed Consumed.		Cost of Feed for Period.	Hours Work Performed.	Average Cost of Feed Per Hour of Work in Cents.	Initial Weight—July.	Final Weight—December.	Gain or Loss in Weight.
	Corn and Cob Meal.	Cottonseed Mixture.						
1	1950.0		$19.49	1101.5	1.77	1082.5	1088.0	5.5
2		2282.5	25.19	1134.5	2.21	1054.7	1121.7	67.0
3	2272.5		22.72	866.0	2.62	1061.2	1205.0	143.8
4		2277.0	26.16	751.0	3.48	1150.0	1248.0	98.0
5	2013.0		20.11	909.5	2.21	1089.0	1185.5	96.5
6		1762.5	21.14	565.5	3.74	1006.2	1093.0	86.8

In the summary given above it will be noticed in each case that the cottonseed meal mixtures cost more for the total period than the corn-and-cob meal rations and that the amount of work done was less with the exception of mule 2, which did slightly more work than its team mate. The cost per hour of work was also greater with the mules fed the cottonseed meal mixture. In each case the weight was not only maintained but a substantial increase was made with one exception. Reference is made to mule 1, which was exceeded in increase of weight by mule 2, fed the cottonseed meal mixture. In the other two cases, the corn-fed mules made slightly larger gains. The results in this case from a financial standpoint are in favor of the corn-and-cob meal rations. It is possible that the cost of the corn-and-cob meal, wheat bran, and cottonseed meal rations might be cheapened by eliminating the wheat bran and substituting a cheaper feed of like nature. The writer has found, however, that wheat bran is a very desirable ingredient in cottonseed meal mixtures.

External Effect of Cottonseed Meal on Draft Animals.

It is conceded by those who have fed cottonseed meal extensively that the use of a small quantity of this concentrate in the ration will improve the coat of the animal and induce spirit and endurance to a certain extent. Experimental evidence from this Station bears out the conclusion that there is a marked effect on the coat of the animal. It becomes smoother and glossier than usual after using cottonseed meal in the ration for a short time. The writer hesitates to make any statement regarding the effect on the spirit and endurance of the animal. However, when the cottonseed meal was fed in moderate quantities, not exceeding one and one-half to two pounds per day, the spirit and endurance of the animals was not below the normal. When larger quantities were fed, however, the mules not only lost in flesh and working capacity, but they refused to eat the cottonseed meal rations except in negli-

gible quantities. Their condition grew so serious while being fed this ration that it was necessary to increase the amount of corn and decrease the cottonseed meal to the amount recommended in this bulletin.

At the close of the experiment, March 1, 1911, the mules were all in normal condition. No trace could be found of any harmful effects resulting from feeding cottonseed meal. This should thoroughly establish the claim that there is no harm from feeding the meal in moderate quantities to work animals. When fed to excess, however, ill effects may arise. This is not likely to occur unless the cottonseed meal fed exceeds considerably the ten per cent allowance of the total ration by weight, which is a safe guide to follow.

General Observations and Conclusions.

In a general way, the practicability of feeding cottonseed meal to draft animals must be determined by the farmer. It is not within the scope of the writer to say just where cottonseed meal can be used to the best advantage. The specific rations must be worked out by the farmer. This publication at best can give only the results which have been obtained under the conditions existing on the Experiment Station Farm, and give general suggestions which may help the farmer in making up his rations. Cottonseed meal can be fed to draft animals in moderate quantities on many farms with very satisfactory results, although the success attained will vary with conditions. For example, the kind of farming practiced, the individuality of the animals, the number of animals fed, the kind of feeds produced on the farm, and the market price of commercial feeds will all be important factors to consider. In a general way, however, very few commercial feeds will be as profitable to the farmer as cottonseed meal when the feed and fertilizer values are given the consideration which they merit. In attempting to work out this problem, the writer has at all times had the fertilizing value of cottonseed meal in mind. If it were not for this factor, it would not be so important to advocate the use of the meal in the ration for draft animals, since the cost of the meal at present is not especially conducive to its use for feeding purposes. Under certain specialized conditions, where cottonseed meal is not so costly and other feeds are relatively cheaper, it may prove more economical to feed the meal. As an example of this exception, the writer believes that on the Louisiana plantations the meal can be fed with greater success than elsewhere because of the other feeds produced which make such a desirable combination with cottonseed meal.

BULLETIN 216 JUNE, 1911

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

OF THE

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

WEST RALEIGH

FEEDING COTTONSEED MEAL TO DRAFT ANIMALS

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WEST RALEIGH, N. C.

TABLE OF CONTENTS

Summary 175
Feeding Cottonseed Meal to Draft Animals 177
Former Use of Cottonseed Meal 177
Value of Cottonseed Meal 178
Nature and Composition of Cottonseed Meal 178
Preliminary Feeding 179
Feeds Adapted for Using with Cottonseed Meal 179
Amount of Cottonseed Meal to Feed 179
Method of Feeding 180
Harmful Effects of Cottonseed Meal 180
A Plausible Reason Why Work Animals Can Use Cottonseed Meal Continuously 180
Data from Practical Farmers 181
Results Obtained by Other Station Workers 183
General Results Obtained from Feeding Cottonseed Meal 185
Some Cottonseed Meal Rations 186

SUMMARY

Cottonseed meal may be used in limited quantities in rations for work stock with satisfactory results, although in some cases animals will refuse it even after repeated attempts to feed it.

It should never be undertaken to feed cottonseed meal alone. It is a very concentrated feed, and for this reason it should be used only as a supplement to carbonaceous and fat producing feeds.

The meal should always be fed with some finely divided concentrate, such as corn-and-cob meal, wheat bran or brewers' grains. The more thorough the mixture of cottonseed meal with the basal feeds the more satisfactory the results will be.

The amount of cottonseed meal to feed daily should rarely exceed two pounds per animal. A safe guide to follow will be to feed one-fifth of a pound of the meal for every hundred pounds live weight. Draft stock exceeding one thousand pounds in weight to any great extent may use two and one-half, and possibly three pounds per day in exceptional cases.

Based on the ration for a work animal of average weight, the amount of meal fed should not exceed fifteen per cent of the total ration by weight. As a general thing the results will be more satisfactory if only ten to twelve per cent of the ration is cottonseed meal.

The results obtained by the writer during three years experimental work show that no ill effects will arise from the use of cottonseed meal if it is used with judgment, however, if it is unduly increased, it will not only be refused but will injure the condition and working efficiency of the animals.

The chief thing in mixing a cottonseed meal ration is to use it in connection with feeds which can be thoroughly incorporated with it, thus avoiding any quantity of the meal sifting through the ration to the bottom of the feed trough. Wheat bran is excellent for this purpose, although its use increases the cost of the ration.

Only bright, fresh, light-colored cottonseed meal should be used. Meal which is of a dark yellow color is most likely to be old and somewhat musty. This stale condition of the meal is no doubt at times responsible for animals refusing it.

Cottonseed meal is an excellent laxative and for this reason it is desirable to feed with corn, aside from the fact that it furnishes the deficiency of protein in corn.

The effect of the meal on the coat of the animal is to make it smooth and glossy, having the same effect in this respect as linseed meal.

The present price of cottonseed meal, which will average about $30.00 per ton, precludes any reduction in the cost of the ration. Its principal value must be derived from the beneficial effect on the coat, condition and digestive system of the animals and in the enhanced value of the manure.

FEEDING COTTONSEED MEAL TO DRAFT ANIMALS.

By R. S. Curtis.

Former Use of Cottonseed Meal.

There has been considerable diversity of opinion regarding the use of cottonseed meal as a feed for draft animals. On the whole, however, the weight of evidence seems to be in favor of this feed for work stock when it is fed with judgment. The writer has found as a result of three years experimental work, that there is no good reason why more cottonseed meal should not be used for this purpose. While the economy of the ration containing the meal will vary under different conditions, so far as the actual use of the feed is concerned in limited quantities in the daily ration, there seems to be no question. When fed in quantities ranging from ten to fifteen per cent of the total ration by weight, it will generally be eaten satisfactorily without any observable detrimental results. At least at the conclusion of experiments extending over a period of three years there was no evidence antagonistic to the continuous use of moderate quantities of this concentrate from the standpoint of health. In one or two cases during the preliminary part of the work some of the animals were impaired temporarily. This was caused, however, by making the substitution of the meal for corn on the basis of food nutrients. For example, in one experiment one pound of cottonseed meal was substituted for three pounds of corn in the ration. This was found to be impractical. Otherwise, at no time during these experiments was the meal fed in unusually large quantities. The final experiments were planned with the idea of keeping below the maximum safe quantity rather than above this amount.

The writer is of the opinion that much of the prejudice against feeding cottonseed meal to draft animals is the result of feeding the meal to excess or from influences based on the detrimental results obtained from feeding the meal to other animals, especially swine.

If cottonseed meal is not used with judgment, it will be far better not to use it in the ration. This does not necessarily mean that special precaution must be taken in order to prevent fatalities as any concentrated feed of this nature must be fed judiciously if the most satisfactory results are to be obtained. It should be kept in mind at all times that cottonseed meal should be used as a supplementary feed, and should never be used as the principal component of the ration for work stock. For some animals, such as beef cattle intended for slaughter, this plan may be followed but not with animals having a continued field of usefulness. In this connection it is not the intention to convey the impression that cottonseed meal should be used to the exclusion of other supplementary concentrates. Considering the feed and fertilizing value of the meal, however, it is thought that a wise use of it in the rations for working animals will be a means of retaining on Southern farms some of the fertility of the by-product which is sold in large quantities in other parts of the country.

Nature and Composition of Cottonseed Meal.

Cottonseed meal is valued as a feed principally because of its high protein content and for this reason it is desired in the ration for work animals which are generally fed on corn exclusively.

Cottonseed meal is one of the most concentrated commercial feeds on the market containing on the average the following nutrients:

TABLE 1.—GIVING THE PERCENTAGE COMPOSITION OF THE NUTRIENTS IN COTTONSEED MEAL.[1]

Water	Ash	Protein	Carbohydrates	Fat
8.5	6.5	41.0	35.0	9.0

Unadulterated cottonseed meal should have a light yellow color and a sharp, nutty odor. If the meal is dark or reddish in color, the presumption is that it is old or it has been adulterated with ground cottonseed hulls which materially reduces its feeding value especially for horses and mules.

Value of Cottonseed Meal.

The reasons for feeding cottonseed meal to work animals may be considered from two viewpoints. First, work stock should be supplied with a ration which will furnish, without the loss of any nutrients, the necessary energy for doing the work required of them. The corn ration which is used largely as a feed for this class of stock is too carbonaceous for economical results, and especially for growing animals. It is necessary to feed a corn ration in excess of the actual needs of the animal in order that the required amount of protein material may be furnished.

Cottonseed meal contains a large amount of protein, and for that reason it is well suited for supplementing corn in a ration for work stock. Theoretically the quantity of meal could be varied in the ration and made to suit the different stages of development in the animal from the growing period to maturity. In practice, however, the amount which can be used successfully is limited. When the ration is properly compounded, the extra quantity of protein needed can be supplied largely from cottonseed meal, and in so doing the ration is made more efficient than a corn ration.

The second reason for feeding cottonseed meal to work animals is to secure its feeding value and at the same time retain in the manure a large percentage of its fertilizing value. The writer considers it a business proposition to secure when possible the feeding value of cottonseed meal before it is used for fertilizing purposes. Each year, the Southern States export about 1,000,000 tons of cottonseed products which should be used here. The work animals in this State alone if fed the quantity of cottonseed meal recommended would consume practically one-tenth of the entire amount of these products exported.

[1]North Carolina Experiment Station Chart—C. B. Williams.

Feeds Adapted for Using with Cottonseed Meal.

Communications from various sources state that work animals will eat cottonseed meal readily either alone or mixed with other feeds. This may be true in isolated cases but such is not uniformly the case according to the experience of the writer. It is possible that animals which have been reared on cottonseed meal from early life may eat it more readily than otherwise. This seems plausible, but experimental results show that animals which have cottonseed meal suddenly placed in the ration do not always adapt themselves to the change even after continued trials.

By supplementing the meal with such feeds as wheat bran, a great many difficulties will be overcome. Wheat bran is considered as one of the best available complementary feeds. Brewers' grains, crushed oats or whole oats, corn-and-cob meal and cut hay are also very useful for this purpose. Crushed or ground husk corn is claimed by some to give splendid results as a basal feed for using with cottonseed meal. The chief thing in feeding the meal is to secure a basal feed which can be thoroughly mixed with it. This lightens the ration and at the same time overcomes the odor which seems disagreeable to many animals. Louisiana planters use quite large quantities of black strap molasses in their cottonseed meal rations for work animals. They attribute their success in feeding the meal largely to the molasses. They state that cottonseed meal is rarely if ever refused by work animals when it is properly incorporated with the basal feed and the whole thoroughly mixed with molasses.

Preliminary Feeding.

In using cottonseed meal in the ration for the first time, the quantity fed should be limited for several weeks. Not over one-fourth of a pound should be given at each feed for the first two or three weeks. This is essential, as overfeeding may be, and no doubt has been responsible for the ill effects following the use of cottonseed meal both with work animals and other live stock. Besides the concentrated nature of the meal, its laxative effect should be closely watched, as overfeeding may cause considerable trouble of this kind. If the animals fed on the meal are not placed on a full feed of two pounds before the end of six weeks, it will be far better than to increase it more rapidly. By observing the above precautions success will be secured where a more rapid introduction of the feed in the ration might cause failure.

Amount of Cottonseed Meal to Feed.

The amount of cottonseed meal to feed should be determined by the size of the animal; the character and severity of the work; the composition of the basal concentrated feeds, and the roughage used. Although it is not likely, if the main concentrates contain a larger percentage of protein than corn, the most commonly used feed, it will not be necessary to use as much cottonseed meal as otherwise. Also, if the roughage consists of clover or cowpea hay or some other nitrogenous roughage, it will not be necessary to use the maximum amount of cottonseed meal recommended.

Method of Feeding.

The method of feeding cottonseed meal will depend somewhat upon the amount used. If the largest amount that can be safely fed is used it will be better to distribute it equally in the three daily feeds. If a smaller quantity is used, for example one pound daily, it may be given in two feeds, preferably the morning and night portion of the ration. The meal should be thoroughly mixed in the main part of the feed, as it might otherwise sift out and gradually collect in the feed trough and ferment.

Harmful Effects of Cottonseed Meal.

The harmful effects from feeding cottonseed meal to work stock are largely due to overfeeding. While the exact cause of the toxicity has never been determined, the meal may be fed in moderate quantities to some farm animals for limited periods with satisfactory results. Its use generally, however, is not recommended, especially for calves and swine, although for dairy and beef cattle and working animals it can be fed without any of the ill effects which frequently follow its use with calves and swine. When fed to work stock in the quantities recommended it can be used without any anticipation of disastrous results.

A Plausible Reason Why Work Animals Can Use Cottonseed Meal Continuously.

It is a well known fact that dairy cattle can use moderate quantities of cottonseed meal in their rations without suffering any of the ill effects which characterize its use with other animals. Even working oxen will eat quite large quantities of the meal apparently without any ill effects. It will be noticed that any class of stock which does not use the feed assimilated for increasing the body weight can usually continue to take the meal in limited quantities without harm. This is well illustrated by the character of the product obtained from dairy cattle and the work obtained from draft stock. While the question may arise regarding the proportionate amount of cottonseed meal actually fed to different classes of stock and the weight of the animals being fed, it might be stated that where pigs have been fed cottonseed meal, cases are on record where those receiving a small amount of meal, one-fourth of a pound daily died in a short period. On the other hand, pigs of the same weight fed one pound of meal daily, continued to live for ninety days, at which time they were discontinued, apparently in normal condition. For this reason and other peculiarities attending the use of cottonseed meal, there seems to be some foundation to the statement that the amount of meal which can be fed continuously will depend somewhat on the character of the product made or the work done by the animal using cottonseed meal.

Any class of animals which use the meal in quantities sufficient to increase their weight materially, namely, beef cattle, and swine, will eventually reach the period when partial or entire blindness, staggers or even death may result. From whatever sources the writer has re-

ceived reports of these troubles with horses or mules, it has been found that more meal was being used in each case than is conservatively recommended for the average draft animal.

Data from Practical Farmers.

In Table 2 some important data is given from men who have had considerable experience in feeding cottonseed meal to draft animals. Their observations were based upon extensive trials with a large number of animals, covering a period of several years. A number of additional names might be added to the list, but this is not felt to be necessary since the results obtained by them were practically the same as those reported in the table.

TABLE 2.—SHOWING THE RESULTS OBTAINED FROM FEEDING MULES AND HORSES ON COTTONSEED MEAL BY PRACTICAL FARMERS IN NORTH CAROLINA AND LOUISIANA.

	List of Questions Submitted and Answers Received.								
Name and Address of Feeders	Number Horses Fed Cottonseed Meal	Number Mules Fed Cottonseed Meal	Length of Time Fed in Years	Pounds Cottonseed Meal Fed Per Day	Feeds Given with Cottonseed Meal	Pounds Cottonseed Meal Fed in Beginning	Animals Ever Refused Cottonseed Meal?	Detrimental Influences Noticed?	Expression of Results Obtained
The Leon Godcheaux Co. Ltd., Reserve, La.	None	300	5	1½—3	Corn-and-cob meal, brewers' grains, and molasses.	¾	Not when fed with molasses	None	Very well impressed
G. B. Reuss, Hohen Solms, La.	10	150	2	1	Ground corn and molasses	1	No	None	Very satisfactory.
Thos. H. Rogers, Thibodeaux, La.	12	120	5	¾	Ground husk corn and molasses	½	Only when cottonseed meal is fed alone	None	Satisfactory feed with molasses
C. S. Matthews, Matthews, La.	25	250	1	1	Ground corn and molasses	1	Only when fed in large quantities	None	----------
John R. Todd, Foster, La.	22	154	1	10% of ration	Oats and corn	------	No	Blindness	----------
John T. Moore Planting Co., Schriever, La.	15	150	13	2 –2½	Corn-and-cob meal, rice bran and molasses	½ –1	No	None	Excellent results
J. J. Jacobs, Convent, La.	6	82	3	2½—3	Brewers' grains, corn and oats	2	No	Overheating and blindness	Satisfactory
Beaufort Lumber Co., Shelmerdine, N. C.	----------	48	2 mo.	1½	Cottonseed hulls	Sm'l am't	Sometimes when first fed	---------	Financial saving
Frank P. Shields, Scotland Neck, N. C.	15	60	3	1½—2	Corn	½	No	Possibly affects eyes	Satisfactory
John Dymond, New Orleans, La.	10	50	5	2	Cut hay and molasses	Full ration	At first only	None	Very satisfactory
R. T. Gibbons, Baton Rouge, La.	5	50	10	2	Crushed corn, oats, cut hay and molasses	¼	No	None	Satisfactory
G. W. Lentill, Bunkie, La.	2	46	6 mo.	2	Corn and molasses	2	At first only	None	Satisfactory

It will be noticed from the results given in Table 2, that the amount of cottonseed meal fed ranged from three-fourths of a pound to three pounds per day, with a daily average of about two pounds. In every case the best results were obtained when the meal was mixed with a feed which had previously been crushed or ground or which was naturally in a finely divided condition. Oats are the best adapted of the farm grains for mixing with the meal without further alteration. In a number of cases reported, oats were used as a part of the basal feed. The Louisiana planters in almost every case mix their feeds as suggested and add from six to twelve pounds of black strap molasses, which seems to materially improve the cottonseed meal ration both in palatability and efficiency. The parties furnishing the data for this table claim that cottonseed meal is not often refused by horses or mules when it is thoroughly mixed with the other basal feeds. This is especially true if molasses is added to give palatability to the ration. In two cases shown in the table, it is stated that the meal caused either blindness or overheating. In this latter case, however, the quantity fed was more than is ordinarily recommended, and this may have been responsible for the trouble. In all cases, except two where expressions were not given, the results obtained were very satisfactory from the standpoint of the working capacity, efficiency and condition of the animals. In one case, it was stated that a financial saving was effected.

Letters submitted to these same parties after a lapse of eighteen months stated that the results from feeding the meal were equally as satisfactory as before. In one case, the feeding had been discontinued. This came about from the fact that an epidemic broke out among the stock, and the meal was eliminated from the ration as a matter of precaution. The company, as well as their veterinary adviser, considers, however, that the trouble was not caused by feeding cottonseed meal.

Results Obtained by Other Station Workers.

It is stated by C. W. Burkett[1] that cottonseed meal can be used to displace part of the corn in the ration for horses and mules. Two pounds of meal are recommended per animal daily. This amount should be fed with grain or sprinkled on dampened hay or ensilage. When animals can be made to acquire a taste for cottonseed meal it is recommended to make it a part of the ration.

The conclusions reached by W. J. Kennedy, E. T. Robbins, and H. H. Kildee[2] were that cottonseed meal gave better results than linseed meal as a supplement to the ration for work stock. The ration containing the cottonseed meal was fully as palatable and efficient and it was less laxative than the oil meal ration. It was also cheaper, when the cottonseed meal was selling at $30.00 per ton. The statement is made in the beginning of the bulletin, however, that the experiments have not been continued for a sufficient length of time to give definite conclusions. This work was carried on through two years.

C. W. Burkett[3] reports the feeding of oats, wheat bran, corn, gluten

[1]N. C. Sta. Bul. 189, p. 104.
[2]Ia. Sta. Bul. 109, p. 435.
[3]N. H. Sta. Bul. 82, p. 34.

feed, linseed meal, and cottonseed meal in various forms to work stock. Fairly good results were obtained with all the mixtures fed, however, cottonseed meal was less satisfactory than any other supplement used in the rations.

W. C. Stubbs[1] fed cottonseed meal to horses and mules with satisfactory results. From one to two pounds were fed to animals daily with satisfaction. Six pounds is regarded as the maximum quantity which should be fed and this amount should be reached gradually. It is stated that reddish and musty cottonseed meal should be avoided.

F. E. Emery[2] reports feeding two pounds of cottonseed meal daily in a mixed ration. When the meal was increased to three and one-half pounds per day, the results were not as satisfactory as when two pounds were fed. The statement is made that neither of the horses fed cottonseed meal showed any bad symptoms from the meal feeding.

E. R. Lloyd[3] fed two lots of mules on cottonseed meal in connection with wheat bran. Lot 1 was fed wheat bran and cottonseed meal in the proportion of 1:1. The mixtures were eaten sparingly at first, and at the end of six weeks were practically refused. The mules were not accustomed to wheat bran and it was thought this might account for their refusing the meal. Corn chops were substituted, however, for the bran, but they still refused to eat enough of the mixture to keep them in good working condition. At the end of ninety days the mules were losing in flesh so rapidly that the cottonseed meal feeding was discontinued.

Dr. Gebeck[4] states that it has been proven that cottonseed meal can be fed to draft animals, especially during the time they are working excessively hard. Horses can be fed about two pounds per day, without harmful effects.

J. H. Connell[5] states that he has fed cottonseed meal to work stock in small quantities. The meal was gradually introduced in the ration to allow the stock to grow accustomed to the taste and odor. By following this practice, a large percentage of the work stock can be induced to eat it regularly although some refuse it entirely. He further states that large amounts have been fed safely to mules.

A number of other statements are made bearing on the results obtained from farmers of that State. While some of the results obtained are antagonistic to the use of cottonseed meal for work stock, considerable evidence is given in support of the value of the meal for this purpose. The average ration recommended should contain about one-tenth part of cottonseed meal by weight.

Judge Henry C. Hammond,[6] of Augusta, Ga., reports that he has fed for years about one pound of cottonseed meal daily to colts, brood mares, driving and work horses. There has been no sickness among the horses and their style, action and health are all that could be desired. He

[1]Louisiana Planter (1902), p. 178.
[2]N. C. Exp. Sta. Bul. 109, pp. 425-426.
[3]Miss. Ann. Rpt., 1902, pp. 16-18.
[4]Landw. Vers. Sta., 42, p. 294.
[5]Tex. Exp. Sta. Bul. 55, p. 206.
[6]Feeds and Feeding, Tenth Edition, Henry, p. 150.

attributes his unvarying success to the fact that the meal is never fed alone but is always carefully mixed with some light concentrate.

This latter statement is of special importance. It is corroborated by a large amount of data obtained by the writer during three years experimental work.

Baron E. d'Allinges[1] fed two pounds of cottonseed meal to horses and mules during three years. It was fed in connection with 4 pounds of wheat bran and 6 pounds of corn meal. On Sundays whole corn, oats and uncut hay were fed. It is reported, however, that the use of cottonseed meal was not altogether satisfactory in this combination.

General Results Obtained from Feeding Cottonseed Meal.

The foregoing digest of the published matter relating to the use of cottonseed meal for horses and mules should have considerable weight, considering the sources of the information. Taking also the supplementary data from practical farmers who have used the meal in large quantities under varying conditions, there seems to be no large amount of evidence contradictory to the successful use of cottonseed meal for the purpose in question.

While in some instances antagonistic statements have been made, the writer is of the opinion that these negative expressions have at times been caused by the careless use of the meal. For example, some writers have advocated the use of as much as four to six pounds per animal daily. The concentrated nature of cottonseed meal would seem to oppose the recommendation of using such large quantities of it. This statement is especially true considering the undesirable effect of other more widely used concentrated feeds on working animals. As cottonseed meal is a heavy finely divided nitrogenous feed mature judgment should always be used in feeding it. It should be given in moderate amounts and in combination with light bulky feeds which will reduce the sodden condition of the meal when fed in large quantities.

On the whole, there is a certain amount of information concerning the use of cottonseed meal which every farmer must acquire for himself. However, if the use of the meal is based on the results given herein and on the experimental results reported by the writer in Bulletin 215, the successful use of it should be considerably increased. Cottonseed meal is a feed which should be given with great care, and when so used it should bring uniformly satisfactory results, although in some cases even under the most careful guidance it may be refused by work animals.

[1]Tex. Exp. Sta. Bul. 55, p. 205.

Some Cottonseed Meal Rations.

The following daily rations for a draft animal of medium weight doing moderate work should prove satisfactory under normal conditions.

Ration 1.

10 pounds corn-and-cob meal.
2 pounds cottonseed meal.

Ration 2.

8½ pounds corn-and-cob meal.
2 pounds wheat bran.
1½ pounds cottonseed meal.

Ration 3.

8½ pounds corn-and-cob meal.
2 pounds brewers' grains.
1½ pounds cottonseed meal.

Ration 4.

9½ pounds ear corn.
3 pounds wheat bran.
1 pounds cottonseed meal.

In using ration 4 it will be preferable to feed the wheat bran and cottonseed meal, thoroughly mixed, at the noon or night feed. If fed at night a small amount of the ear corn ration might well be given at this time. The roughage portion of the ration may be eaten *ad libitum*, the principal portion of it being fed at night.

It will be found advisable to mix the concentrates in 100 or 200 pound lots or even in larger quantities. This will save time in mixing, and the rations will be more convenient to feed.